Space Weather Technical Forecast

Issued on Sunday, 05 June 2022 at 01:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active Electron Fluence. Chance of G1-G2/Minor to Moderate Storm intervals late Day 1 or Day 2 (5th-6th) from possible CME arrival(s).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low, with no significant flares during the period. There are four numbered sunspot regions, however these are all small and simple regions that are either stable or showing signs of decay as they traverse towards the west limb. Two further very small regions have become visible near the east limb, as they move into a clearer view. A filament eruption was observed in the northwest disc around 05/0300 UTC, with an associated CME assessed as likely passing to the north and behind Earth, but with a non-zero chance of a glancing impact. No other Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, has been at background levels through the period, mainly below 300 km/s. Density has been mostly average. The total interplanetary magnetic field strength, Bt, has been weak at 4nT or below, with the north-south component, Bz, varying weakly between +/- 4nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at background levels. The high energy electron flux (greater than 2 MeV) has been at High levels, reaching a peak of 9520 pfu at 04/1655 UTC. Electron fluence has been above the Active threshold throughout, reaching 5.22e8 integrated pfu at 05/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Very Low, with a chance of C-class flares.

Solar Wind / Geomagnetic Activity: There are three potentially Earth-directed CMEs, although all are low confidence. The first two are from filament eruptions that occurred around 01/0100 UTC and 02/0530 UTC and are expected to pass 05/1800+/-12 hours, and 06/0000 +/-12 hours. The first is very weak, but more Earth-directed, with the second slightly faster but likely to give only a glancing impact. However these could also potentially combine to give a single arrival. The third, is the filament eruption around 04/0300 UTC, and is expected to miss, but with a low chance of glancing impact late on day 3 (7th). Otherwise no other solar wind enhancements are indicated, with mainly background winds expected. Geomagnetic activity is forecast to be predominately Quiet, but increasing to Unsettled to Active should any CME arrivals occur. These will also give a chance of isolated G1-G2 Minor to Moderate storms, mainly with any magnetic cloud on day 2 (6th).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) is expected to be at background levels during this period. High energy electron flux (greater than 2MeV) is expected to be at High levels at first, before likely dropping out with any CME arrival later day 1 or day 2 (5th or 6th). Some recovery in values is possible days 3-4 (7th-8th), potentially to high, however this is low confidence. The associated 24 hour fluence is expected to persist at Active (above 1e8 integrated pfu), but potentially falling below later day 2 or day 3 (6th-7th) in response to any dropout that occurs from any CME arrivals, and otherwise with a

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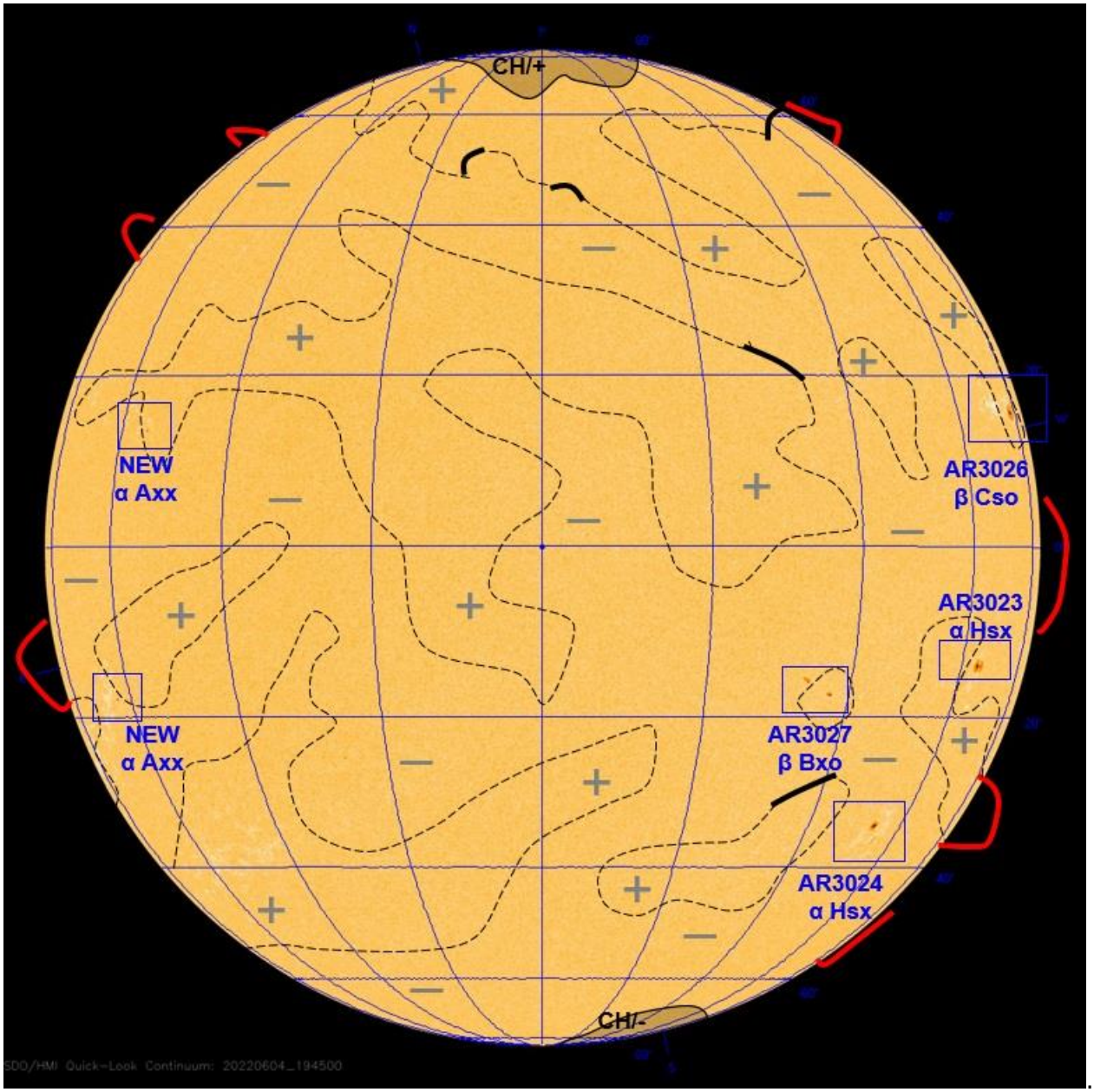
gradually decreasing trend.

Figure 1. Solar Analysis Valid 04/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament lift-off was observed from the centre disc around 01/0100 UTC, with an associated coronal dimming. A weak CME was produced, which has been assessed as a slow CME, giving a slight chance of a glancing blow late day 2, around 05/1800UTC +/- 12 hours. A further filament eruption sourced CME was also observed leaving the southwest disc around 02/0530 UTC. This has the potential for a glancing blow around 06/0000 UTC +/- 12hours. Both CMEs are low confidence, however there is also the potential for a combined arrival, perhaps increasing the strength of any a geomagnetic response, most likely with any magnetic cloud moving through on the 6th.

A further, third CME was observed leaving the northeast disc due to a filament eruption around 04/0300 UTC. This is missing north and behind Earth, however a glancing influence isn't impossible late on the 7th or early 8th (day 3-4).

Aside from the CMEs, background wind speeds are expected to persist through the period with no notable coronal hole fast wind enhancements expected.

Geomagnetic activity is forecast to be predominately Quiet, but increasing to Unsettled to Active for a time late day 1 and during day 2 (5th and 6th) should any CME arrival occur. These will also give a chance of isolated G1-G2 Minor to Moderate storms, mainly with any magnetic cloud on day 2 (6th). There is a very slight chance of similar enhanced geomagnetic activity day 3 with the third CME, but otherwise expected to ease back to mainly Quiet.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	30	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1300	Partial	Filament	4N 10W	252 km/s	05/1800 +/- 12 hrs	Limited shock. Weak
02/1315	Partial	Filament	6S 45W	525 km/s	06/0000 +/- 12hrs	Glancing impact possible.
04/1032	Partial	Filament	32N 30E	620 km/s	Miss	Glance possible late 7th or early 8th

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Figure 2: ENLIL including ensemble

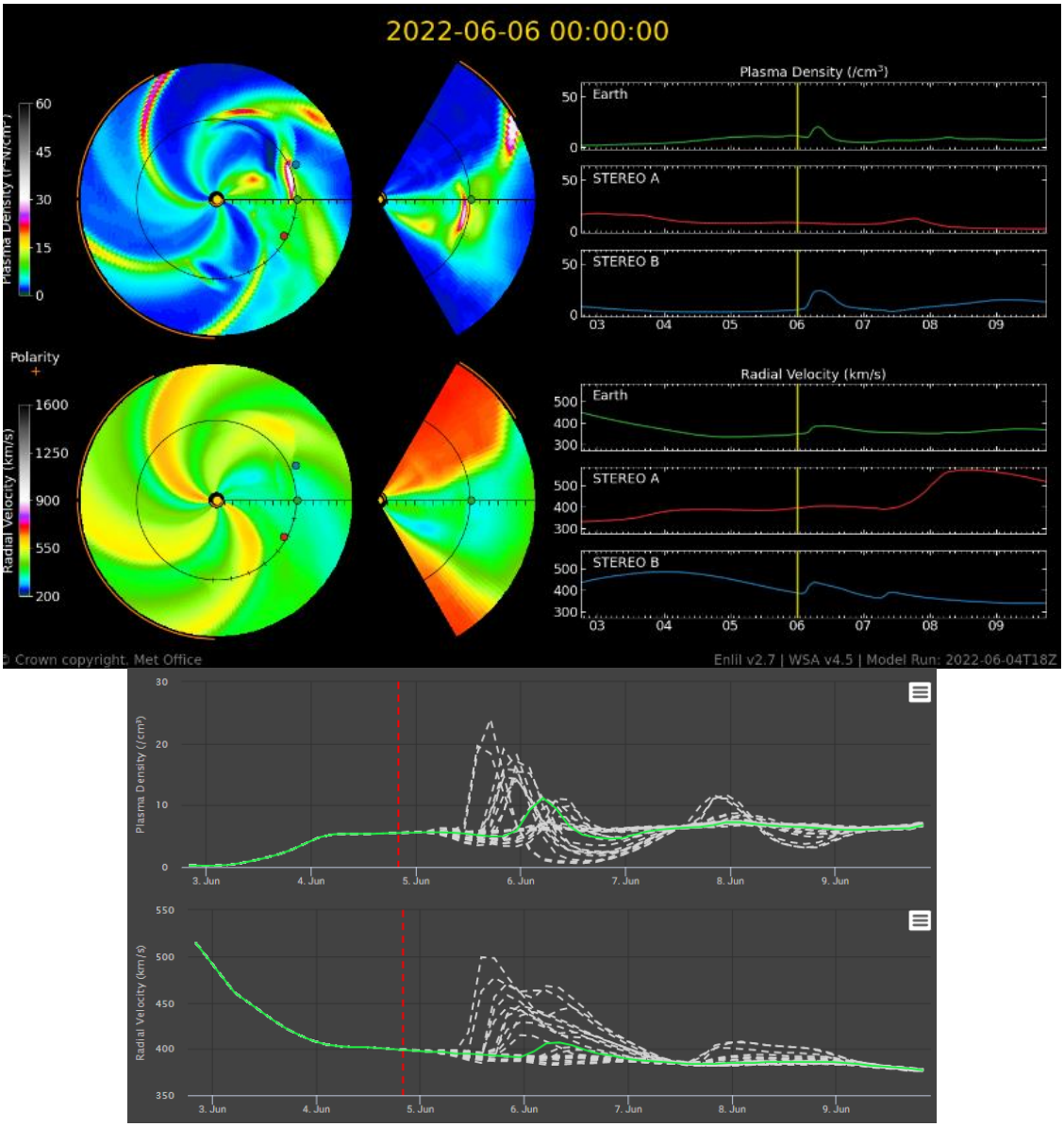
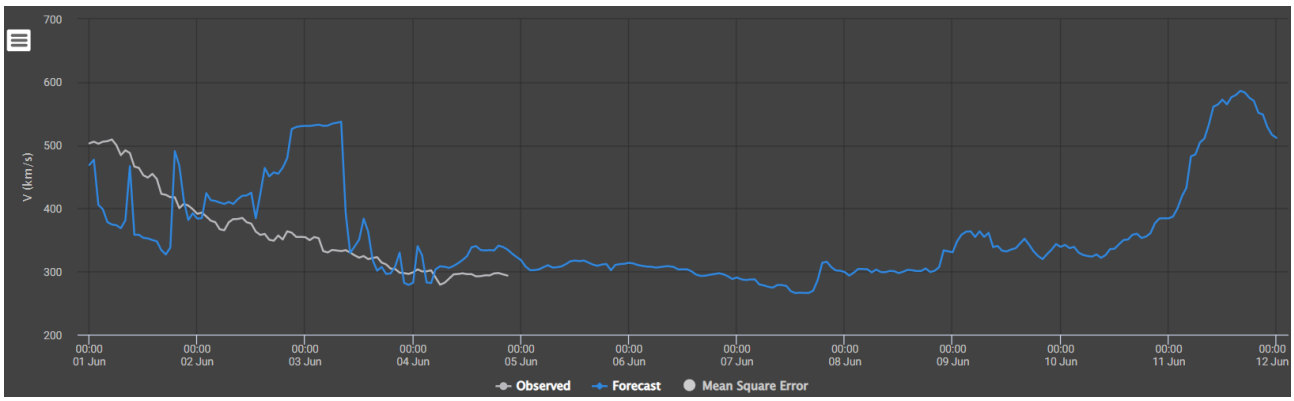


Figure 3: Solar Wind Persistence Model – No fast wind enhancement expected until at least the 11th.



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Radio Blackouts - X-Ray Flares:

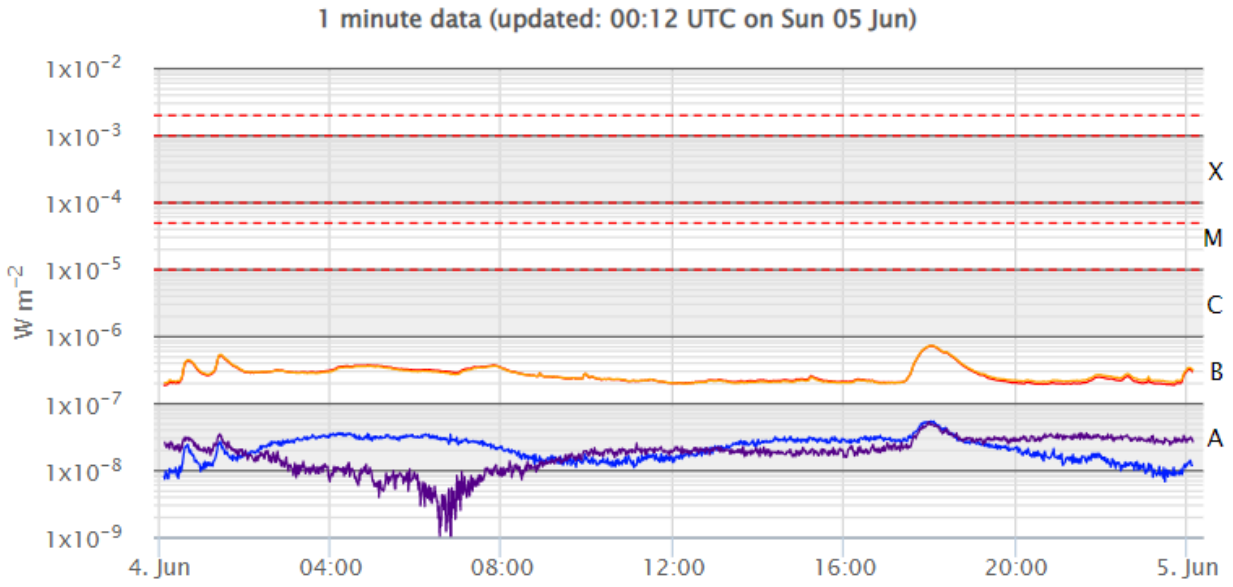
Solar Activity is currently Very Low, with only low B-class flares observed.

There are four small and simple numbered sunspot groups on the disc, including AR3026 Cso/Beta. AR3023 Hsx/alpha, and AR3024 Hsx/alpha which are approaching the east limb, along with AR3027 Bxo/Beta which will also soon rotate towards the east limb. These regions are all stable, or showing signs of decline. There are also two small Axx/alpha spot regions set amongst regions of plage towards the west limb, however these are currently not showing any sign of development.

Very Low activity is therefore likely to continue with just a chance of increasing to Low with any C-flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	2	2	2	2
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: GOES-16/17 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at this level through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 has been at High (greater than 1000pfu) levels through the last 24 hours due to the fast wind enhancement that occurred a few days ago. These mainly High levels are expected to persist until the potential arrival of two CMEs late day 1 or day 2 (5th or 6th), which are likely to cause levels to drop out, before a recovery to Moderate to High levels day 3 and 4 (7-8th).

The associated 24 hour electron fluence is currently Active (greater than 1e8 integrated pfu) and is expected to persist at this level into day 2 (6th). Confidence then falls for continuing Active levels into day 3 and 4 (7th-8th), due to the potential drop out of flux that occurs, along with an uncertain recovery following. Observed fluence is currently running much higher than REFM expectations, and consequently expected to remain well above the REFM forecast.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	95	40	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 5: GOES-16 >2MeV Electron Flux and associated Fluence (blue) with REFM (white) and persistence (yellow) forecasts

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